nigra, *C. ochroleuca*, *C. rutifolia*, *Cirsium serrulatum*, *C. discolor*, and *C. lanceolatum*. The motion seems most active when the anthers are ready to shed their pollen, and, as pollen-gathering insects anticipate the observer, it is best to cut the flowers and place them in water in a room. Endeavoring to observe the motion of *Cirsium discolor* in the growing plant almost failed from this cause, but on drawing a light substance over the whole head, some of the florets were found to move.

In the *Centaurea* flowers on the table, the best period for observing the motion is when the anthers which cover the apex of the pistil seem about to allow the pistil to protrude. If then touched, the pollen is seen to issue from the mouth of the united stamens, and the whole crown of anthers to decline. Cohn, above cited, gives the exact measurement of this contraction, and explains the mechanism by which the contraction is accomplished. At the same time, if the motive power be very active, the whole upper portion of the floret, moves in some direction, apparently without order or system. Sometimes it is in a lateral direction, at other times upwards or downwards, and sometimes describing a circle round its own axis. In some cases the motion is communicated to other florets—two and sometimes three moving to the touch of a single one. In ten minutes after the exhibition of irritation, it is ready for another fit, and goes through the motions, though less actively than before. Mr. Meehan had failed to get any motion three times from the same floret, and not always two. Touching the pistil had no effect unless the force was sufficient to press one side against the anther. The irritation seemed to be confined to the stamens, and through these probably down by their nervous connections through the achenium, and in this way communicating with the nerves which run up through neighboring achenes to the stamens which they support.

Since the above communication was made to the Academy, Mr. J. H. Redfield believes that the neutral ray florets in *Centaurea Americana*, which have neither stamens nor pistil, also possess the power of motion, and Miss Powell, without knowledge of Mr. Redfield's observation, notes a similar experience.

SEPTEMBER 18.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Thirty-one persons present.

The death of John C. Trautwine, a member, was announced.

Notes on the Sequoia gigantea.—Mr. MEEHAN remarked that so much had been written about the mammoth trees, that there seemed little room for more; but to one of the fullest accounts given, namely, that by Mr. Muir in the Proceedings of the Meeting of

the American Association for the Advancement of Science, at Buffalo, 1876, he believed he might add a few additional facts, drawn from or suggested by a visit made to a few of the groves during the past summer. He could confirm the statement of Mr. Muir that there were comparatively few young plants growing among the old ones in the Calaveras or Mariposa groves. In the latter spot a few might be found in swampy places. Many of the large trees were also growing in swampy ground, while some were found where the ground would be pronounced quite dry. Mr. Muir gave 5000 feet as about the elevation of the trees in these—the northern part of the belt occupied by them. On the southern part of the belt Mr. Muir found them at about 8000 feet, and there numerous young trees formed the great mass of the undergrowth, and furnished an abundance for a perfect succession of forest trees. Here Mr. Muir found them in ground not swampy, as well as in situations as swampy as possible, and he concludes that the *Sequoia gigantea* is a tree which has the power of growing in dryer and wetter soil than most other species. He adds: "It is constantly asserted in a vague way, that the Sierra (in past times) was vastly wetter than now, and that the increasing drouth will of itself extinguish *Sequoia*, leaving its ground to other trees supposed capable of flourishing in a dryer climate. But that *Sequoia* can and does grow on as dry ground as any of its present rivals, is manifest in a thousand places. 'Why, then,' it will be asked, 'is *Sequoia* always found in greatest abundance in well-watered places where streams are exceptionally abundant?' Simply because a growth of sequoias always creates these streams. * * * Drain the water, if possible, and the trees will remain; but cut off the trees, and the streams will vanish." He has seen a fallen trunk make a dam of 200 feet long, and similar bogs made by roots and fallen trunks damming the earth, are familiar features in the more luxuriant sequoia forests. On this bare suggestion Mr. Muir builds as if it were a demonstration, and proceeds to say: "Since the extra moisture found in connection with the denser growths is an effect of their presence, instead of a cause of their presence, then notions, * * * based upon its supposed dependence on greater moisture, are shown to be erroneous."

In the light of these views, Mr. Meehan said he had carefully examined the trees in the groups scattered from the Fresno to Calaveras, and could say that in these localities the sequoias possessed no more power of making the ground swampy than any other tree which might form the leading forests in heavy wooded districts. The huge specimens of *Pinus Lambertiana*, *Pinus ponderosa*, and the thick groves of *Libocedrus*—huge, though averaging at best but two-thirds the diameter of the mammoth sequoias—did not make the ground swampy in the slightest degree. Mr. Muir's supposition—for it surely cannot be regarded as such a demonstration as science requires—would give us small swamps, at least, for the smaller trees.

Experience of forest growths in the eastern states gave abundance of facts, which were quite sufficient to explain the existing state of things, on grounds very different from those assumed by Mr. Muir. Observers knew that there were trees which loved moisture, and trees which preferred dry ground. Swamp-lovers would grow in dry places almost as well as in wet ones, but the dry-lovers would not grow in wet places. The swamp magnolia, swamp willow, swamp azalea, the bald cypress, the swamp maple, the sweet gum—every swamp tree that can be named—do just as well, and in many cases better, in dry ground. This is so well known to every intelligent cultivator of trees, that its correctness is beyond dispute. Here in the east, the largest red maples, willows, cypresses, and other swamp trees, are the occasional specimens which by accident find themselves on dry ground. On the other hand, the dry-land species of pine, oak, maple, and other trees, can under no circumstances be made to grow in wet places; and, therefore, if Mr. Muir's suggestion that the *Sequoia* was once a dry-land plant, and made the land swampy through its own growth, should by any possibility be found correct, it would probably be an exceptional case in the vegetable kingdom. It had been shown by himself, the speaker said, in past communications to the Academy, printed in its Proceedings, that trees only grow in swamps from a provision of nature that their seeds shall only germinate in wet places. It seems like a determination of nature that some trees shall grow in swamps, whether they prefer it or not. Though these trees grow better and fruit freely in dry ground, the trees cannot spread, because there is not the moisture required for the seed to grow.

Mr. Muir mistakes the argument. It is not that sequoias will not grow in dry ground, but that the seed will not germinate to any extent except under highly humid conditions. Ground need not be absolutely wet. The cultivator raises swamp ferns on bricks, and the swamp rhododendron is often found on rocky ledges, but this is only where a humid atmosphere keeps the seed from drying till it grows. The atmospheric humidity at 8000 feet would be more likely to help *Sequoia* at 8000 feet than at 5000. In concluding this branch of the topic he said the facts spoke for themselves. The seed did not grow now—there were no seedlings—though seeds were abundant. They grew in former times or the trees would not exist. There must be some change in the conditions necessary to make seeds grow since the forest was started. We know from outside observations that seed of swamp-loving trees will not grow under arid conditions. We see that the *Sequoia* is a swamp-lover. Is not this getting to as close an explanation as science rarely reaches? May we not say that *Sequoia* does not spread because the humid conditions are not as they once were when the forests were founded? This was certainly his conclusion from the facts as they presented themselves to his observation.

If this be incontrovertible, it opens up an interesting question as to the cause of the desiccation in the vicinity of the big trees. The ratio of disintegration in a mountain peak, by the frost, rains, and elements generally, and the descent of the loose mass to the lower lands by the simple law of gravity alone, would depend on the width of the peak, as well as the nature of the material. In the process of ages, peaks covered with snow would be lowered till they were no longer snow-capped in summer, and thus lower regions in the vicinity, covered perchance with *Sequoia*, would be under dryer atmospheric conditions. To a greater or less extent this must be the case in all mountain changes, but whether this could have been going on to any appreciable extent in the few thousand years during which these trees have occupied the spot, is a question for geologists to determine. However, Mr. Muir himself gives good reasons for the belief that these trees followed from the west, eastwardly, in the close wake of retreating glaciers, and when the atmospheric moisture, as well as that of the earth contiguous, must have been more moist than now.

In regard to the age of the trees, Mr. Meehan said doubts had been expressed whether the *Sequoia* might not make more than one annual circle of wood a year, and thus render the count by these annual circles unsafe. He had given close attention to this point on the ground, by measuring the height of thrifty young trees, and estimating by the growth per year the probable age. A tree of say thirty, forty or fifty feet, would be seen to be about that many years old. The diameter of the trunk would then be taken and found to correspond with the one annual ring per year in the sections of the larger trees, as per actual count. There would be no question but the larger trees were over 2000 years old.

He found that when about three or four hundred years old, the trees ceased to increase in height to any appreciable degree, the effort of the tree being more in a lateral direction, and the nutrient matter necessary to the building up of the trunk was mainly the work of the side branches. The height of one called "Haverford," after our sister college, he found, by a rough triangulation, to be about 249 feet.

SEPTEMBER 25.

Rev. Dr. H. C. McCOOK, Vice-President, in the chair.

Thirty-seven persons present.

The death of Alexis T. Cope, a member, was announced.

Restoration of Limbs in Tarantula.—Rev. Dr. McCOOK remarked that the tarantula exhibited had been kept in confinement nearly a year, fed during winter on raw beef and in summer on grasshoppers. In the spring it cast its skin, by a laborious